Appendix 16

Flood Risk Assessment

ARUP

Indaver

Ringaskiddy Resource Recovery Centre

Flood Risk Assessment

Reference: 307174_REP/1

Issue 5 | 29 August 2025

Job number 238129-00

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Contents

Executive Summary

Indaver proposes to develop a resource recovery centre in Ringaskiddy in County Cork. The proposed development will consist principally of a waste-to-energy facility (waste incinerator) for the treatment of up to 240,000 tonnes per annum of residual household, commercial and industrial non-hazardous and hazardous waste and the recovery of energy. Of the 240,000 tonnes of waste, up to 24,000 tonnes per annum of suitable hazardous waste will be treated at the facility. The proposed development will maximise the extraction and recovery of valuable material (in the form of ferrous and non-ferrous metals) and energy (in the form of 21 megawatts of electricity) resources from residual waste.

In addition to the provision of the waste-to-energy facility, the proposed development will include an upgrade of a section of the L2545 road, a connection to the national electrical grid, an increase in ground levels in part of the site, coastal protection measures above the foreshore on Gobby Beach and an amenity walkway towards the Ringaskiddy Martello tower.

A flood risk assessment is required as part of the planning application of the project. This report details the flood risk assessment carried out by Arup. It has been undertaken in accordance with the Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG).

The site for the Ringaskiddy Resource Recovery Centre is located approximately 15km to the south-east of Cork City, in the townland of Ringaskiddy on the Ringaskiddy Peninsula in the lower part of Cork Harbour. The site occupies an area of approximately 13.55 hectares and is approximately 800m east of the village of Ringaskiddy. The L2545, the main road from Ringaskiddy village to Haulbowline Island forms the northern boundary of the site. The eastern boundary of the site extends to the foreshore of Cork harbour along Gobby Beach. The lands to the immediate south and west are in agricultural use. The site surrounds the Hammond Lane Metal Recycling Co Ltd facility.

In broad terms, the potential sources of flooding to the site at Ringaskiddy can be categorised as follows: Tidal/Coastal Flooding, Pluvial Flooding, Groundwater Flooding and Urban Drainage. Given the site's proximity to Cork Harbour, the main source of potential flooding at the site is tidal.

Given the absence of any significant watercourse from the site (or in proximity to the site) the risk of fluvial flooding is negligible.

Based on a review of all available information, the predicted 1 in 200-year design tidal level for the site and adjacent L2545 roadway has been determined to be 2.87m OD. Sections of the road close to the Gobby Beach car park are below this level and are therefore at risk of tidal flooding during a 1 in 200-year tidal event.

There is a known risk of pluvial flooding to the L2545 and the low-lying areas of the site during periods of heavy rainfall, primarily due to tide locking and limitations in the existing drainage network. The recently completed Ringaskiddy urban realm and active travel scheme has enhanced the performance of the local drainage infrastructure – recent upgrades will alleviate flooding of the western fields as they will stop water flowing into the western fields from the road (as there are gullies there now). However, during exceptional pluvial events there may be a slight residual risk of flooding to low-lying areas of the site which are not to be developed.

Small areas of the site along the northern boundary are also below the predicted 1 in 200-year design tidal level (2.87m OD), but these are not proposed for development. The majority of the site is above 2.87m OD.

There is a low risk of groundwater flooding to the site.

The Indaver site is not indicated as being within the design 1000-year tidal floodplain. Consequently, the site is classified as lying within Flood Zone C.

The minimum design flood defence level of the proposed development has been calculated as 3.42m OD. Arup however has proposed a more conservative flood defence level of 4.55m OD for the site. This level offers a very high standard of flood protection to the site.

It is proposed to raise the footprint of the site to a minimum of the proposed site flood defence level of 4.55m OD. This includes all internal roads, car parking area and all associated site works. This measure will ensure that the risk of flooding to the site is very low.

The finished floor level of the buildings on the site will be set at even higher levels – the administration building and ESB substation will be set at 5.0m OD while the floor level of the main process building varies from 5.0m to 7.0m OD. The Turbine and Aero-Condenser buildings will be set at 11m OD.

It is proposed to upgrade the L2545 to address the risk of flooding of the road. The upgrade works will include raising a 190m section of the road to a maximum height of 3.495m OD between the car park adjacent to Gobby Beach and the eastern end of the Hammond Lane Metal Company site. This is approximately 0.9m above the existing road level. This will elevate the road to above the 200-year design tidal water level plus an allowance for climate change. This will offer a high level of protection to the road from tidal flooding and will help ensure that access and egress routes can be maintained during flood events.

A new dedicated surface water drainage system will be installed as part of the L2545 upgrade works to collect, convey, and attenuate runoff from the road before reconnecting into the existing drainage network for discharge to the foreshore. These improvements build upon the enhancements made under the Ringaskiddy urban realm and active travel scheme and are intended to improve the road's resilience to pluvial flooding and tide locking during extreme weather events

These measures are sufficient to ensure that the risk of flooding of the site and the L2545 is very low.

It is considered that the proposed development at Ringaskiddy should be classified as a "Highly Vulnerable Development" as per the vulnerability classification. As the site is classified as Flood Zone C, a Justification Test is not required for the proposed development, and it is necessary only to identify mitigation measures for any residual risks.

A wave modelling and erosion study of the area of the Indaver site was undertaken by Arup in 2015 and is detailed in the Coastal Erosion Report submitted as part of the 2016 planning application. An updated coastal assessment was undertaken in 2025 as part of the 2025 EIS (Refer to **Appendix 13.3** ***Coastal Erosion Study EIS 2025***).

Based on the Coastal Erosion Study (2025) Arup has recommended that the Indaver coastal boundary is monitored on an annual basis and the placement of approximately 1,150m^3 of sacrificial material (shingle of appropriate size and rounded shape with high density and resistance to abrasion) above the foreshore on Gobby Beach along the eastern boundary of the Indaver site.

This will be a 'soft' solution which will potentially reduce erosion rates by limiting the exposure of the toe of the glacial till face to wave action. The main aim of placing the material is to act as a proactive measure for the coastal area adjacent to the Indaver site only.

1. Introduction and Background

1.1 Project Background

The proposed development will consist principally of a waste-to-energy facility (waste incinerator) for the treatment of up to 240,000 tonnes per annum of residual household, commercial and industrial non-hazardous and hazardous waste and the recovery of energy. Of the 240,000 tonnes of waste, up to 24,000 tonnes per annum of suitable hazardous waste will be treated at the facility. The proposed development will maximise the extraction and recovery of valuable material (in the form of ferrous and non-ferrous metals) and energy (in the form of 21 megawatts of electricity) resources from residual waste.

In addition to the provision of the waste-to-energy facility, the proposed development will include an upgrade of a section of the L2545 road, a connection to the national electrical grid, an increase in ground levels in part of the site, coastal protection measures above the foreshore on Gobby Beach and an amenity walkway towards the Ringaskiddy Martello tower.

A flood risk assessment is required as part of the planning application of the project. This report details the flood risk assessment carried out by Arup. It has been undertaken in accordance with the Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG).

1.2 Scope of Study

Following best practice in undertaking flood risk, the study includes the following:

- Review of all relevant information and data, as outlined in **Section 1.3** below
- Review the risk of fluvial, tidal, groundwater and pluvial flooding
- Review of access/egress routes to the site
- Review of available Site Investigation data
- Recommendations on a suitable site flood defence level, taking account of climate change and freeboard
- Development of potential mitigation measures (if necessary)
- Commentary on any residual risk
- Preparation of a Flood Risk Assessment Report

1.3 Summary of Data Used and Assumptions Made

In preparing this report, the following data was collated and reviewed:

- Review and analysis of relevant reports from the Lee CFRAM Study, January 2014 (available to download from http://www.leecframs.ie/)
- Predicted extreme water levels and flood extent maps from the Irish Coastal Protection Strategy Study (ICPSS), May 2011. These are available from the website of the Office of Public Works (www.opw.ie)
- Flood history of the site from the OPW National Flood Hazard Mapping website (www.floodmaps.ie)
- Preliminary Flood Risk Assessment (PFRA) Mapping produced by the OPW, March 2012 (www.cfram.ie/pfra)
- Site Geological and hydrogeological data from the Geological Survey of Ireland website (www.gsi.ie) (note: datasets accessed in March 2025)

- Guidelines for Planning Authorities on 'The Planning System and Flood Risk Management' published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DEHLG)
- Relevant information from the Ringaskiddy Waste to Energy Facility – EIS Coastal Recession and Sea Flooding Assessment (published in 2008)
- Coastal Erosion Report (Arup 2015) included in the Indaver Ringaskiddy Resource Recovery Centre EIS 2016
- **Appendix 13.3** ***Coastal Erosion*** Study EIS 2025
- Results from the Site Investigation carried out at the Indaver site in 2000 and 2001
- Aerial photography and mapping from Google Maps (2015)
- Water level data from a number of periods from the gauge maintained at Cobh by the Port of Cork
- Ringaskiddy Resource Recovery Centre planning application site layout drawings for the proposed development
- The available topographical survey information for the site (2014 and 2025 surveys)

All Ordnance Datum (OD) levels referred to in this report are to Malin Head Ordnance Datum unless otherwise stated.

1.4 Site Description and Proposed Development

1.4.1 Site Description

The site for the Ringaskiddy Resource Recovery Centre is located approximately 15km to the south-east of Cork City, in the townland of Ringaskiddy on the Ringaskiddy Peninsula in the lower part of Cork harbour. The site occupies an area of approximately 13.55 hectares and is approximately 800m east of the village of Ringaskiddy. Refer to **Figure 1** below.

The L2545, the main road from Ringaskiddy village to Haulbowline Island forms the northern boundary of the site. The eastern boundary of the site extends to the foreshore of Cork harbour along Gobby Beach. The site surrounds the Hammond Lane Metal Recycling Co Ltd facility. The site is relatively level to the immediate south of the L2545 road and rises up steeply to the south. At the top of this steep scarp the ground rises more gently to the southern site boundary along the top of the ridge.

The National Maritime College of Ireland and the Beaufort Research Laboratory (UCC) are located to the North of the site. Access to these premises is from the existing L2545 road.

Figure 2 presents and outline of the site.

Figure 1 Location of the existing Indaver site

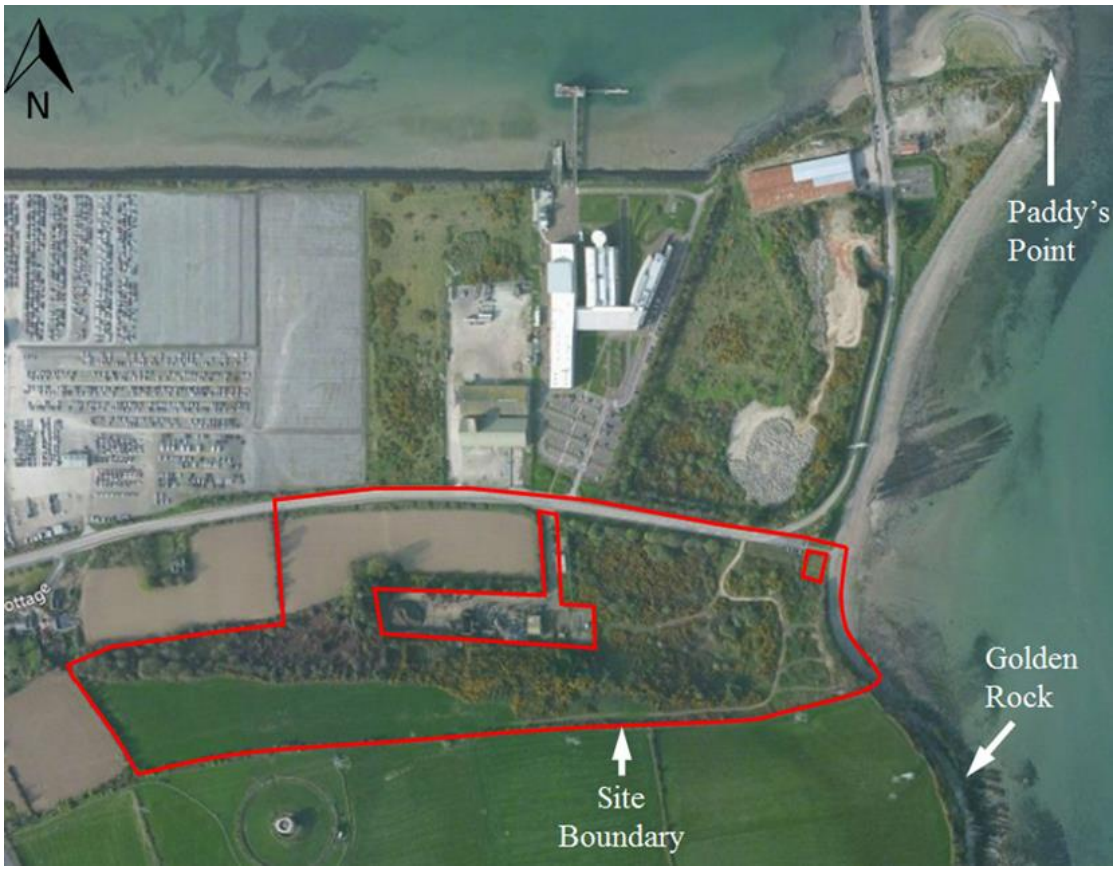

Figure 2 Outline of the existing Indaver site (2015 on top, 2025 on bottom)

Based on the 2025 topographic survey, the toe of the slope varies from 2.7m OD at the western end to 3.15m OD at the eastern end. The top of the slope varies from 35.9m OD at the western end to 11.6m OD at the eastern end.

Figure 3 presents the ground levels of the site. The image has been annotated with spot heights which present the existing ground levels.

Figure 3 Existing ground levels of the site

1.4.2 Proposed Development

The proposed development will consist principally of a waste-to-energy facility (waste incinerator) for the treatment of up to 240,000 tonnes per annum of residual household, commercial and industrial non-hazardous and hazardous waste and the recovery of energy. Of the 240,000 tonnes of waste, up to 24,000 tonnes per annum of suitable hazardous waste will be treated at the facility. The proposed development will maximise the extraction and recovery of valuable material (in the form of ferrous and non-ferrous metals) and energy (in the form of 21 megawatts of electricity) resources from residual waste.

In addition to the provision of the waste-to-energy facility, the proposed development will include an upgrade of a section of the L2545 road, a connection to the national electrical grid, an increase in ground levels in part of the site, coastal protection measures above the foreshore on Gobby Beach and an amenity walkway towards the Ringaskiddy Martello tower.

The coastal protection measures proposed along the eastern boundary of the Indaver site will consist of the placement of shingle above the foreshore along the section of Gobby beach within Indaver ownership. This shingle will act as beach nourishment on the beach and will slow the retreat rate of the glacial till cliff.

Further details on the coastal protection measures are provided in **Section 7.7** of this report and the Environmental Impact Statement which accompanies the planning documentation. The main elements of the proposed development include:

- Main process building
- Turbine hall and aero condenser structure
- Security building/gate house
- Administration building
- Firewater storage and pump house
- Firewater retention tank and storm water retention tank
- Weigh bridges
- Electricity substation, compound and grid connection
- Light fuel oil storage tank
- Emergency access
- Public amenity footpath
- Increase in ground levels
- L2545 road upgrade
- Coastal protection measures
- Diversion of services
- Grid connection

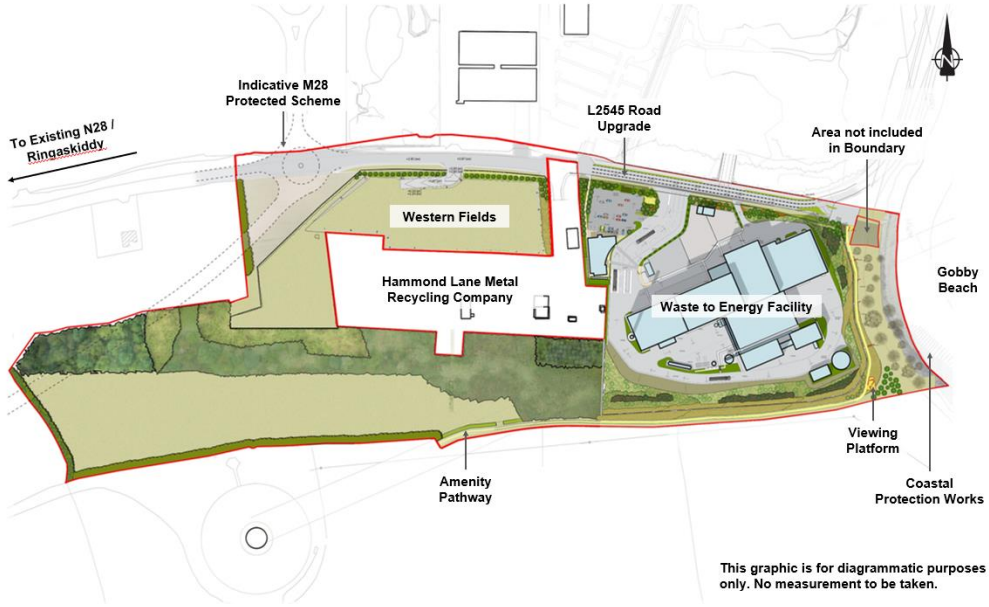

Figure 4 Outline of the proposed development

2. Planning Context

The following planning policy documents are relevant to the assessment of this proposed development:

- The national planning guidelines published by the OPW and the Department of the Environment, Heritage and Local Government in November 2009 entitled 'The Planning System and Flood Risk Management: Guidelines for Planning Authorities' are particularly pertinent and are discussed in **Section 2.1.1** below
- In terms of planning policy context, the provisions contained in the following document are relevant:
  - Cork County Development Plan 2022-2028
  - Ballincollig Carrigaline Municipal District Local Area Plan, August 2017

2.1 The Planning System and Flood Risk Management Guidelines

2.1.1 Introduction

In November 2009, the Department of Environment, Heritage and Local Government and the Office of Public works jointly published a Guidance Document for Planning Authorities entitled "the Planning System and Flood Risk Management".

The guidelines are issued under Section 28 of the Planning and Development Act 2000. Planning Authorities and An Bord Pleanála are therefore required to implement these Guidelines in carrying out their functions under the Planning Acts.

The aim of the guidelines is to ensure that flood risk is neither created nor increased by inappropriate development.

The guidelines require the planning system to avoid development in areas at risk of flooding, unless they can be justified on wider sustainability grounds, where the risk can be reduced or managed to an acceptable level.

They require the adoption of a Sequential Approach (to Flood Risk Management) of Avoidance, Reduction, Justification and Mitigation and they require the incorporation of Flood Risk Assessment into the process of making decisions on planning applications and planning appeals.

Fundamental to the guidelines is the introduction of flood risk zoning and the classifications of different types of development having regard to their vulnerability.

The management of flood risk is now a key element of any development proposal in an area of potential flood risk and should therefore be addressed as early as possible in the site master planning stage.

2.1.2 Definition of Flood Zones

Flood Zones are geographical areas within which the likelihood of flooding is in a particular range.

There are three types of flood zones defined in the Guidelines as follows:

Flood Zone A	Probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding)
Flood Zone B	Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 year and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding)
Flood Zone C	Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas which are not in zones A or B

2.1.3 Definition of Vulnerability Classes

The following table summarises the Vulnerability Classes defined in the Guidelines and provides a sample of the most common type of development applicable to each.

Highly vulnerable development	Includes Garda, ambulance and fire stations, hospitals, schools, residential dwellings, residential institutions, essential infrastructure, such as primary transport and utilities distribution and SEVESO and IPPC sites, etc.
Less vulnerable development	Includes retail, leisure, warehousing, commercial, industrial and non-residential institutions, etc.
Water compatible development	Includes Flood Control Infrastructure, docks, marinas, wharves, navigation facilities, water-based recreation facilities, amenity open spaces and outdoor sport and recreation facilities

2.1.4 Types of Vulnerability Class Appropriate to Each Zone

The following table illustrates the different types of Vulnerability Class appropriate to each Zone and indicates where a Justification Test will be required.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable	Justification test	Justification test	Appropriate
Less vulnerable	Justification test	Appropriate	Appropriate
Water compatible	Appropriate	Appropriate	Appropriate

2.2 The Cork County Development Plan 2022 - 2028

The Cork County Council Development Plan 2022 – 2028 sets out Cork County Council's overall strategy for the proper planning and sustainable development of Cork County over a 6-year period. This supersedes the Ballincollig Carrigaline Municipal District Local Area Plan, August 2017.

The plan seeks to secure the development and improvement in a sustainable manner of the economic, environmental, cultural and social assets of the County. The plan governs the functional area of Cork County Council excluding the areas governed by the City Council.

A County wide Strategic Flood Risk Assessment (SFRA) was undertaken as part of the Development Plan and was prepared in accordance with 'The Planning System and Flood Risk Management Guidelines (OPW, 2009).

The plan makes specific reference to the Lee CFRAM Study and how its findings will be used to identify areas at risk of flooding (Flood Zone A, Flood Zone B and Flood Zone C) in the County in additional to the findings of the PFRA mapping.

The Cork County Development plan's flood risk objectives are reproduced in the following figure.

County Development Plan Objective
WM 11-15: Flood Risk Assessments

To require flood risk assessments to be undertaken for all new developments within the County in accordance with The Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009) and the requirements of DECLG Circular P12/2014 and the EU Floods Directive.

- For sites within Flood Zone A or B, a site specific Flood Risk Assessment will be required.
- For sites within Flood Zone C, an examination of all potential sources of flooding, and consideration of climate change (flood risk screening assessment), will be required. In limited circumstances where the 'Flood Risk Screening assessment' identifies potential sources of flood risk, a site specific flood risk assessment may also be required.
- All proposed development must consider the impact of surface water flood risks on drainage design through a Drainage Impact Assessment. The drainage design should ensure no increase in flood risk to the site, or the downstream catchment.

County Development Plan Objective
WM 11-16: Flood Risks – Overall Approach

Take the following approach in order to reduce the risk of new development being affected by possible future flooding:

- Avoid development in areas at risk of flooding; and
- Apply the sequential approach to flood risk management based on avoidance, substitution, justification and mitigation of risk.
- Where development in floodplains cannot be avoided, applications for development must meet the definition of Minor Development or have passed the Justification Test for Development Plans in the updated SFRA and can pass the Justification Test for Development Management to the satisfaction of the planning authority.
- Consider the impacts of climate change on the development.

In areas where the Justification Test for Development Plans has not been applied, or has been failed, the sequential approach should be applied as follows:

- In areas where there is a high probability of flooding - 'Flood Zone A' - avoid highly and less vulnerable development as described in Section 3 of 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' issued in November 2009 by DoEHLG.
- In areas where there is a moderate probability of flooding - 'Flood Zone B' - avoid 'highly vulnerable development' described in section 3 of 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities' issued in November 2009 by DoEHLG.
- In areas where there is low probability of flooding – 'Flood Zone C' all uses may be considered subject to a full consideration of all flood risks.

County Development Plan Objective
WM 11-17: Development in Flood Risk Areas

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2 of the Guidelines, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
   a. The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
   b. The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
   c. The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
   d. The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and predicted future use of the development and the local development context.

The development is assessed not to have the potential to give rise to negative or adverse impacts on the integrity of Natura 2000 sites or Natural Heritage Areas or proposed Natural Heritage Areas.

Figure 5 Extract from Cork County Council's Development Plan 2022-2028

3. Overview of Flood Hazard and Historic Flooding

3.1 Overview

In broad terms, the potential sources of flooding to the site at Ringaskiddy can be categorised as follows:

- Tidal/Coastal Flooding
- Pluvial Flooding
- Groundwater Flooding
- Urban Drainage

Given the site's proximity to Cork Harbour, the main source of potential flooding at the site is tidal which is considered in the following section of the report.

Other sources of flood risk are discussed in **Section 5.**

The risk of flooding from wave overtopping is considered to be very low for the site given the relatively small design wave heights incident on the site. The reader is referred to the Coastal Erosion Report that forms part of this planning application for a detailed description of the wave modelling work undertaken by Arup (**Appendix 13.3** ***Coastal Erosion Report***). Flooding from wave overtopping is therefore not considered as part of this FRA.

3.2 Historic Flooding of the Site and Access Road

3.2.1 Review of Data from OPW's 'floodmaps.ie' Website

Reports and maps from the OPW website www.floodmaps.ie have been examined at the time of writing of this report (2025) as part of this flood risk assessment. Given the absence of any flood defences or arterial drainage schemes at the Indaver site, the Land Commission Maps, Benefitting Land Maps and Drainage District Maps presented on the website are not relevant to this FRA.

There is however a number of post-flood event reports which detail some of the flood events in the area. Reports from two tidal flood events are presented as follows:

- February 2014 surge event
- October 2004 surge event

These are discussed in more detail below.

3.2.2 February 2014 Event

On 3 and 4 of February 2014, a surge event occurred around the Irish coast leading to coastal flooding at a number of locations.

A short description of the flooding experienced in Ringaskiddy is provided in one of the post flood event reports. It states:

"Floodwater extended approx. 60m from the car park at end of local road (L2545) and was approximately 13 – 15 inches deep. No properties were flooded as part of this event. Access to Haulbowline was shut off."

It is noted that the report does not indicate the likely return period of the event.

A map highlighting the location of the flood event is also provided in the flood report and it is reproduced in **Figure 8** below. It is noted that the figure has a label stating "Extents of Flood Waters" but there is no actual flood extent presented on the figure.

Figure 6 Flood location map for the February 2014 event extracted from the flood maps website

The flood report does not explicitly state that any of the Indaver site was flooded in this event.

Recordings from the water level gauge at Cobh which is maintained by the Port of Cork are presented in **Figure 9** below. It can be seen from the plot that the maximum water level for the event was 2.42m OD and it was recorded at 07:09am on 3 February 2014.

It was also stated that the Nautical Almanac suggests that the tide in Ringaskiddy is 0.1m above the level of the tide in Cobh giving an approximate value of 2.52m OD at Ringaskiddy for the October 2004 event. This tidal water level is correspondent to an event with a return period of approximately 1 in 10 years.

It is noted that the lowest level of the road in the vicinity of the Gobby Beach car park is approximately 2.4m OD and the level of the car park is between 2.7m OD and 2.8m OD.

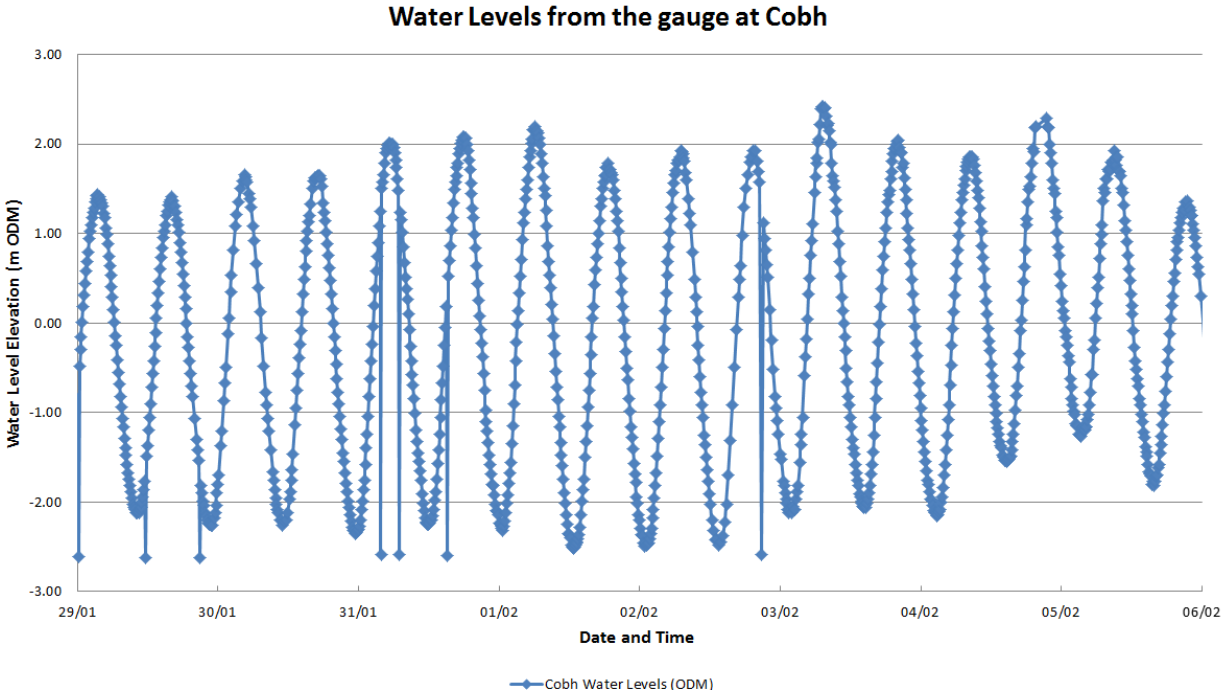

Figure 7 Water level data from the gauge at Cobh. This data was provided by the Port of Cork in 2014

3.2.3 October 2004 Event

A surge event also occurred around the Irish coast on 27 October 2004. The impact of this event on the Ringaskiddy area is provided in one of the post flood event reports. It states:

"The surface of the car park has been significantly damaged, and part of the sea wall has been washed away."

This car park corresponds to the area that experienced flooding in the February 2014 coastal flood event as detailed in the previous section.

It was stated that the recorded water level at Cobh for the event was 2.66m OD. It was also stated that the Nautical Almanac suggests that the tide in Ringaskiddy is 0.1m above the level of the tide in Cobh giving an approximate value of 2.76m OD at Ringaskiddy for the October 2004 event. If considering this to be a tidal water level, it is correspondent to a return period of between 1 in 50 and 1 in 100 years. It is noted that the lowest level of the road in the vicinity of the Gobby Beach car park is approximately 2.4m OD and the level of the car park is between 2.7m OD and 2.8m OD.

A number of photographs of the aftermath of the event are also provided in the flood reports available from floodmaps.ie and are reproduced in the following figures:

- **Figure 10** shows the local road (L2545) flooded (which had a possible contribution from pluvial inundation)
- **Figure 11** shows part of the Indaver site to the west of Hammond Lane flooded. This area is indicated on plan view in **Figure 12**

It is not stated at what time these photographs were taken, so it is not possible to determine the maximum extent of flooding at the peak of the event.

It is noted that only photos from the 2004 event are provided on floodmaps.ie. There are no photos provided of the 2014 event.

Figure 8 L2545 road adjacent to Indaver site shown as flooded after the 2004 event

Figure 9 Part of the Indaver site (western fields) to the west of Hammond Lane shown flooded after the 2004 event

Figure 10 Location of the flood extent in western fields area (blue shading) presented in Figure 9

3.2.4 Other Historic Flooding Events at the Site

In addition to the recorded flood events as presented on floodmaps.ie, Arup have obtained information on two other flood events in the vicinity of the site:

- A tidal flood event in the Cork area in 1994 caused pluvial flooding to the site and the L2545 roadway. No further information is available on this storm event
- The site was subject to flooding in December 2015 as a consequence of Storm Frank passing over Ireland. A high tide level of 2.09m was recorded at Ringaskiddy. This is approximately 1.2m below the level that would result in direct tidal flooding of the road. It is evident therefore that the flooding arose due to the extreme rainfall and was pluvial in nature

4. Tidal Flood Risk

4.1 Lee CFRAM Study

The final hydraulics report and final predictive flood maps from the Lee CFRAM study were made available on the project website in early 2014.

As the Indaver site in Ringaskiddy was studied as part of the Lee CFRAM Arup has consulted the report and the maps to determine the flood risk at the site.

The design tidal flood extent map for Ringaskiddy from the Lee CFRAM Study is reproduced in **Figure 13** below. Three separate return period events are presented on the map:

- 1 in 10 year
- 1 in 200 year
- 1 in 1000 year

The site of the proposed development is outlined in red. As can be seen from the figure, the Indaver site is not indicated as being within any of the three modelled floodplains. Consequently, the site is not located within Flood Zone A or B. It is therefore classified as lying within Flood Zone C. (Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding).

It is noted that any area that is not within Flood Zone A or Flood Zone B is automatically designated as Flood Zone C as per OPW guidelines.

It can be seen from the figure that the site boundary extends along Gobby Beach which borders the 1 in 200-year design tidal flood extent. Given that the beach is subject to tidal inundation (as it is set at a lower elevation than the main area of the site) its flood zoning has been discounted for the purpose of flood zone classification.

The Indaver site is outlined in red. It is noted that the two hatched areas indicated within the site boundary are not within Indaver ownership.

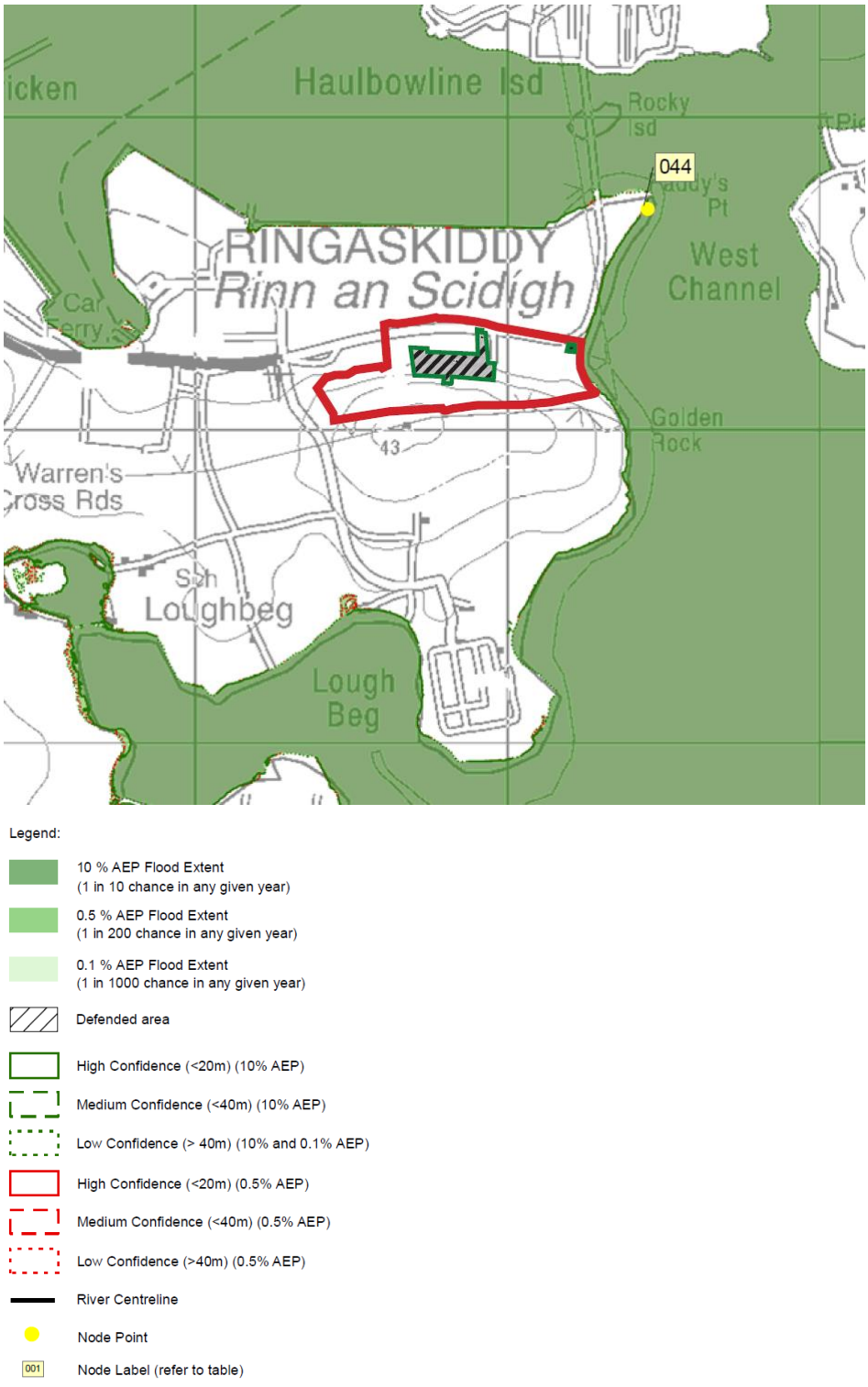

Figure 11 Predictive tidal flood extent map in the area of the Indaver site at Ringaskiddy

The 10-, 200- and 1000-year design tidal water levels as estimated by the Lee CFRAM study for a number of location nodes within Cork Harbour are presented in **Figure 14** below. The node located closest to the Indaver site is the node labelled "044".

The location of node 044 is indicated in the flood extent map shown above (**Figure 13**). (Note 10% AEP is 1 in 10-year design tidal water level, 0.5% AEP is 1 in 200 year design tidal water level and 0.1% AEP is 1 in 1,000 year design tidal water level.).

It can be seen that the 200-year design tidal flood level according to the Lee CFRAM study for the current climate scenario for node 044 is estimated as 2.66m OD. The majority of the ground levels within the Indaver site are above 2.66m OD. Small sections along the northern boundary and in the western fields area are lower than 2.66m OD (Refer to **Figure 3** above).

	Water Level (mOD) per AEP		
Node Label	WL 10%	WL 0.5%	WL 0.1%
033	2.41	2.71	2.87
034	2.38	2.69	2.84
035	2.37	2.67	2.82
036	2.36	2.66	2.82
037	2.37	2.67	2.82
038	2.37	2.67	2.82
039	2.36	2.66	2.82
040	2.35	2.66	2.81
041	2.34	2.64	2.8
042	2.35	2.65	2.81
043	2.36	2.66	2.81
044	2.36	2.66	2.81
045	2.35	2.66	2.81

Figure 12 Design tidal water levels as estimated by Lee CFRAM study

4.2 Irish Coastal Protection Strategy Study (2011)

Output from the Irish Coastal Protection Strategy Study (ICPSS) is available from the OPW's website and was consulted as part of this FRA to determine the extent tidal flooding as predicted by the study. Two datasets from the ICPSS for Cork Harbour were examined as part of this FRA:

- Predicted extreme water levels for a range of return periods for a location close to the site of interest
- Predicted flood extent maps for the design 200-year tidal flood event

The 1 in 200 year predicted tidal floodplain for the Indaver site in Ringaskiddy is presented in **Figure 15** below. As with the Lee CFRAM 1 in 200-year flood extent map, it is evident from the figure that the Indaver site (outlined in red) is not located within the predicted floodplain.

It is noted that unlike the Lee CFRAM maps presented in the previous section, the ICPSS maps do not include the area of the harbour in the flood extent i.e. the harbour area is not indicated as shaded in the map.

The predicted extreme water levels for a number of points within Cork Harbour are given below in **Figure 16**. The point located nearest to the Indaver site is C_2 and for ease of reference is plotted in **Figure 15.**

The extreme water levels for this point are assumed to approximate to the extreme water levels of the Indaver site given its close proximity.

It can be seen that the predicted 200-year current scenario design tidal water level for the Indaver site is 2.73m OD. This value is marginally higher (0.07m) than the level predicted by the Lee CFRAM Study (2.66m OD). As mentioned previously, the majority of the ground levels within the Indaver site are above 2.73m OD. Small sections along the northern boundary and in the western fields area are lower than 2.73m OD (Refer to **Figure 3**).

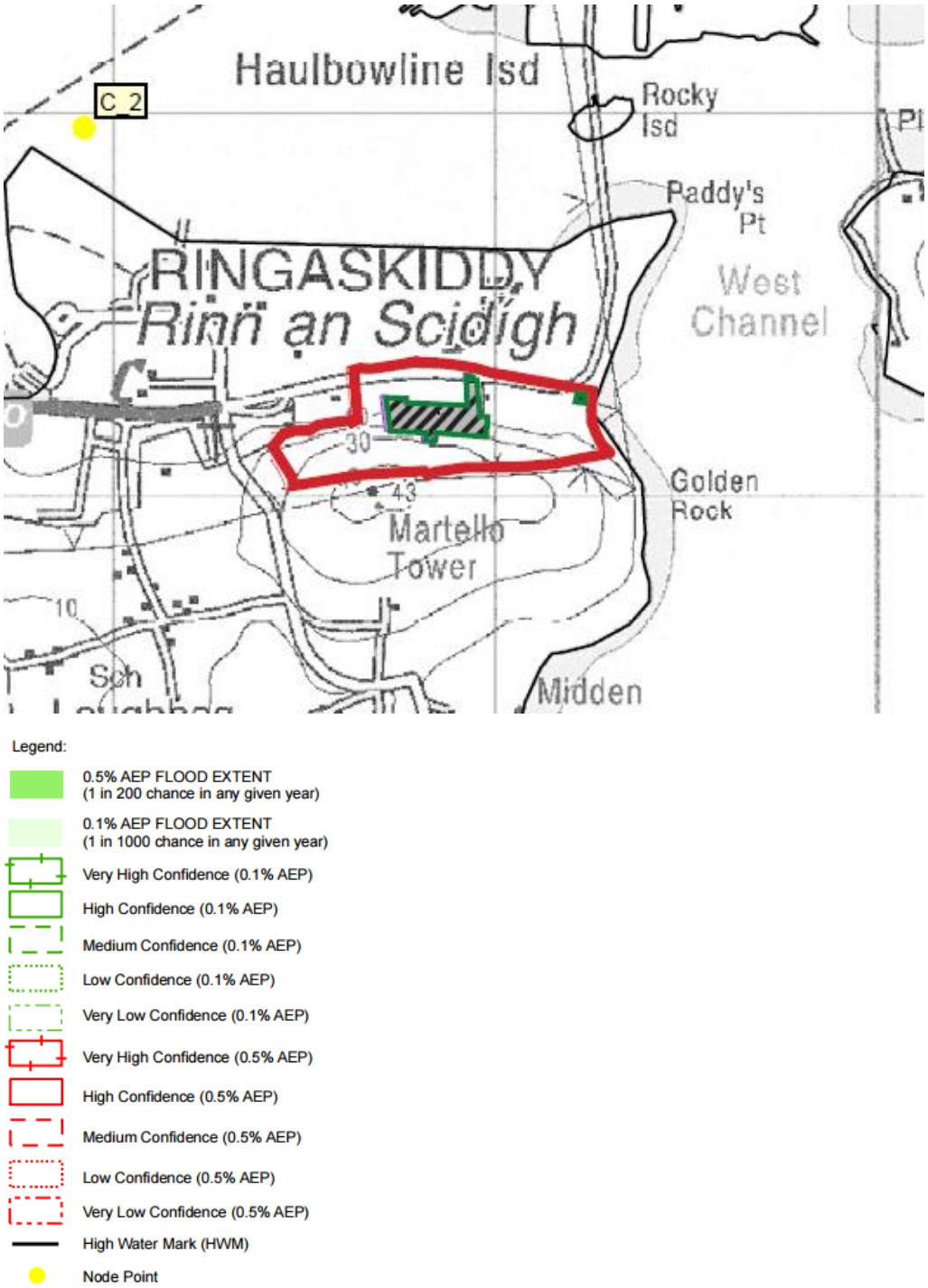

Figure 13 ICPSS 1 in 200-year tidal floodplain. The Indaver site is highlighted in red

		Point C_1	Point C_2	Point C_3	Point C_4	Point C_5	Point C_6
Coord-inate	Longitude	-8.30	-8.32	-8.37	-8.26	-8.20	-8.25
	Latitude	51.82	51.84	51.88	51.85	51.85	51.83
Height to mean sea level for different AEP	50%	2.29	2.34	2.44	2.32	2.34	2.32
	20%	2.39	2.44	2.54	2.42	2.44	2.41
	10%	2.45	2.50	2.61	2.48	2.50	2.48
	5%	2.52	2.57	2.68	2.55	2.57	2.54
	2%	2.61	2.65	2.77	2.63	2.65	2.63
	1.00%	2.67	2.72	2.83	2.70	2.72	2.69
	0.50%	2.74	2.78	2.90	2.76	2.78	2.75
	0.10%	2.89	2.93	3.05	2.91	2.93	2.90
MSL to OD Malin		-0.207	-0.207	-0.209	-0.204	-0.202	-0.204
seich / set-up allowance		0.100	0.150	0.200	0.150	0.150	0.100
Height to OD Malin for different AEP	50%	2.19	2.28	2.43	2.27	2.29	2.21
	20%	2.28	2.38	2.53	2.36	2.38	2.31
	10%	2.35	2.45	2.60	2.43	2.45	2.37
	5%	2.41	2.51	2.67	2.49	2.52	2.44
	2%	2.50	2.60	2.76	2.58	2.60	2.52
	1.00%	2.56	2.66	2.82	2.64	2.66	2.59
	0.50%	2.63	2.73	2.89	2.70	2.73	2.65
	0.10%	2.78	2.88	3.04	2.85	2.87	2.80

Figure 14 Predicted extreme water levels from the ICPSS for a number of points within Cork Harbour

It can be seen that the predicted 200-year current scenario design tidal water level (0.5%) for the Indaver site is 2.73m OD.

4.3 Irish Coastal Water and Wave Study (ICWWS)

The Irish Coastal Wave and Water Level Modelling Study (ICWWS) from 2018 provides an update to the Extreme Coastal Water Levels for the coast of Ireland, originally presented as output from the Irish Coastal Protection Strategy Study (ICPSS) undertaken between 2004 and 2013, which estimated water levels for a range of Annual Exceedance Probability (AEP) events at a series of points around the coast of Ireland.

The knowledge of extreme water levels around the coast is a key element in the assessment of risk associated with coastal flooding and coastal change and the development of associated management strategies. It also allows informed decisions to be made on related coastal risk management schemes and provides the information to inform the design of such schemes. These extreme water levels are also critical for estimating and modelling the potential wave climate at the shoreline, and for providing the joint probability information required to undertake wave overtopping, flood and other risk assessments, where relevant.

When a comparison was made between the ICWWS 2018 and ICPSS water levels to OD Malin (OSGM02), an increase in extreme water levels was evident at the majority of estimation points.

The Phase 1 study outputs include extreme sea level estimates for a series of estimation points around the coast of Ireland. These values are based on analysis and modelling, including:

- Numerical Modelling of combined storm surges and tide levels which was used to estimate extreme water levels along the coastline
- Statistical extreme value analysis and joint probability analysis of both historic recorded tide gauge data and data generated by numerical modelling, which allowed an estimation of the extreme

The simulation of total water levels requires the consideration of atmospheric effects alongside astronomical tidal effects. Consequently, wind speed and pressure data extending over the full model domain was required. For the ICPSS, the European Centre for Medium-Range Weather Forecasts (ECMWF) re- analysis and operational data was used to inform the meteorological element of the simulations, details of which can be found in the ICPSS reports (References 1-6).

For this update study, further meteorological input data for all newly identified storm events was obtained from the ECMWF, ERA5 global re-analysis model, which was made available in 2019 and thus differs from the meteorological data used for the ICPSS.

Output from the ICWWS is available from the floodinfo.ie website and was consulted as part of this FRA to determine the extent of tidal flooding as predicted by the study.

The predicted extreme water levels for a range of return periods for Cork Harbour from the ICWWS were examined as part of this FRA:

The predicted extreme water levels for a number of points within Cork Harbour are given below in **Figure 17**. The point located nearest to the Indaver site is C_2 (as plotted in **Figure 15**).

The extreme water levels for this point are assumed to approximate to the extreme water levels of the Indaver site given its close proximity.

It can be seen that the predicted 200-year current scenario design tidal water level for the Indaver site is 2.87m OD. This value is marginally higher (0.21m) than the level predicted by the Lee CFRAM Study (2.66m OD), and marginally higher (0.14m) than the ICPSS study (2.73m OD). The majority of the ground levels within the Indaver site are above 2.87m OD. Small sections along the northern boundary and in the western fields area are lower than 2.87m OD (Refer to **Figure 3** above).

			C1	C2	C3	C4	C5	C6
	Coord-inate	Longitude	-8.300	-8.320	-8.370	-8.260	-8.200	-8.250
		Latitude	51.820	51.840	51.880	51.850	51.850	51.830
ICWWS 2018	MSL to OD Malin (OSGM02)		-0.13	-0.12	-0.03	-0.15	-0.18	-0.16
	Water Level - metres to OD Malin (OSGM02) (including seiche/set-up)	50%	2.25	2.36	2.61	2.32	2.32	2.25
		20%	2.35	2.47	2.73	2.42	2.42	2.35
		10%	2.42	2.55	2.82	2.50	2.50	2.43
		5%	2.49	2.62	2.90	2.58	2.58	2.50
		2%	2.59	2.72	3.01	2.68	2.68	2.60
		1.00%	2.66	2.79	3.09	2.75	2.75	2.67
		0.50%	2.73	2.87	3.18	2.82	2.83	2.74
		0.10%	2.89	3.04	3.37	3.00	3.00	2.91
ICPSS	MSL to OD Malin (OSGM02)		-0.21	-0.21	-0.21	-0.20	-0.20	-0.20
	Water Level - metres to OD Malin (OSGM02) (including seiche/set-up)	50%	2.19	2.28	2.43	2.27	2.29	2.21
		20%	2.28	2.38	2.53	2.36	2.38	2.31
		10%	2.35	2.45	2.60	2.43	2.45	2.37
		5%	2.41	2.51	2.67	2.49	2.52	2.44
		2%	2.50	2.60	2.76	2.58	2.60	2.52
		1.00%	2.56	2.66	2.82	2.64	2.66	2.59
		0.50%	2.63	2.73	2.89	2.70	2.73	2.65
		0.10%	2.78	2.88	3.04	2.85	2.87	2.80

Figure 15 Predicted extreme water levels from the ICWWS and ICPSS for a number of points within Cork Harbour

It can be seen that the predicted 200-year current scenario design tidal water level (0.5%) for the ICWWS for the Indaver site is 2.87m OD.

4.4 Previous Arup Studies

Arup undertook an Environmental Impact Assessment in 2008 for a similar development on behalf of Indaver at the same site. The EIS included an investigation of the effects of coastal erosion and coastal flooding along the Eastern boundary of the Indaver site. As part of the EIA, design tidal water levels for a number of return period events were estimated through statistical analysis of historic water levels in Cork and subsequently translating these levels to Ringaskiddy.

The 200-year design tidal level at Ringaskiddy however was not estimated as part of the study. The level was instead taken from what was at the time provisional findings of the Lee CFRAM study.

The design tidal levels for a range of return periods from the 2008 EIS study are reproduced in **Figure 18** below.

Return period [years]	Level in RK [m ODMalin]
200	3.04
100	2.86
50	2.70
20	2.49
5	2.15
2	1.94

Figure 16 Design tidal levels from the EIS study. RK corresponds to Ringaskiddy

There is a difference of 0.38m between the finalised Lee CFRAM 200-year design tidal water level of 2.66m OD (which was published in 2014) and the value quoted in the EIS study of 3.04m OD (which was published in 2008). As the Lee CFRAM was only in draft format at the time of writing the EIS in 2008, the data was provisional and has now been superseded in the final CFRAM report.

The final Lee CFRAM 1:200-year design tidal level figure for Ringaskiddy is 2.66m OD. The ICPSS 1:200-year design tidal level figure for Ringaskiddy is 2.73m OD. The ICWWS 1:200-year design tidal level figure for Ringaskiddy is 2.87m OD. Therefore, it can be concluded that the 1:200-year design tidal level figure of 3.04m OD for Ringaskiddy quoted in the 2008 EIS was a very conservative estimate.

Regarding a possible rise in water level owing to Climate Change, the 2008 EIS refers to an "unofficial" assessment of the predicted rise by the OPW as being equal to 0.55m. This value was subsequently adopted by the OPW but at the time of the EIS it was not published in any official documentation and was therefore discounted from the study.

Instead, the EIS followed a more conservative recommendation included in a 2006 report entitled "Flood and Coastal Defence Appraisal Guidance", published by the UK Department for Environment, Food and Rural Affairs (Defra). Following the recommendations in this report the climate change allowance for the site at Ringaskiddy was estimated to be 1m.

Utilising a free board value of 0.5m, the flood defence level in the 2008 EIS was recommended as:

3.04m (200yr tidal level) + 1.0m (climate change) + 0.5m (freeboard) = 4.55m OD

The October 2004 flood event was also reviewed as part of the 2008 EIS. It was stated that the recorded water level at Cobh for the event was 2.66m OD. It was also stated that the Nautical Almanac suggests that the tide in Ringaskiddy is 0.1m above the level of the tide in Cobh giving an approximate value of 2.76m OD at Ringaskiddy for the October 2004 event.

The results of the Lee CFRAM Study suggest that a design water level of 2.76m OD at Ringaskiddy has a return period in excess of the 1 in 200-year event (2.66m OD).

In 2011, Arup prepared a report for UCC which outlined the engineering aspects of what was then the proposed UCC research facility at Ringaskiddy (and what is now known as the Beaufort building). The report considered the structural, geotechnical and environmental aspects of the building.

A flood risk assessment was also carried out as part of the study in 2011, and it recommended a site flood defence level of 4.55m OD. This conservative value was subsequently adopted as the finished floor level of the Beaufort building.

5. Other Potential Sources of Flooding

5.1 Fluvial Risk

The nearest identified watercourse (based both on EPA mapping of watercourses and OPW's mapping of watercourses) is the Glounatouig Stream which discharges at Rafeen Creek some 3 km to the west-northwest of the Indaver site. There is no risk of the Indaver site flooding from the Glounatuoig Stream because of both given the wide expanse of its floodplain and the elevation of the topography between the watercourse and the site.

5.2 Pluvial Risk to the Site

OPW's PFRA mapping (**Figure 19**) indicates that there is a risk of pluvial flooding (orange shading) along the Northern boundary of the site. Flooding of this type has been experienced previously and was in fact presented earlier in this report in **Section 3.2** when the field to the access road was shown as being flooded in a post flood event photograph from the 2004 event.

Figure 17 PFRA mapping for the area of the Indaver site

5.3 Pluvial Risk to the Road

Based on a review of historic flooding events, discussions with Cork County Council, and the PFRA mapping presented in **Section 5.2**, there is a recognised risk of pluvial flooding along the L2545 and adjacent low-lying areas of the site during periods of heavy rainfall, particularly when combined with high tide conditions.

The existing stormwater drainage system along the L2545 consists of a 450mm diameter pipe, which has limited capacity and is unable to accommodate the volume of runoff generated during intense rainfall events. Additionally, there are relatively few gullies along the road to collect and convey surface water to the sewer. The dominant drainage mechanism is "over-the-edge" runoff to the Indaver site on the southern side of the road, where informal channels have been cut into the berm to allow water to drain into the western field area. As parts of this field lie below the adjacent road level, flooding of the road can result in flooding of the site.

The local drainage network discharges to the sea at Gobby Beach via an outfall with an invert level of -0.28m OD. When tidal levels rise above this elevation, the system can become tide locked due to insufficient differential head at the outfall. In such conditions, surface water is unable to discharge, causing the drainage pipe to surcharge. Any subsequent rainfall cannot drain away through the gullies, leading to flooding of the road—particularly in the area adjacent to the entrance to the public car park at Gobby Beach.

While the Ringaskiddy urban realm and active travel scheme has recently improved sections of the drainage infrastructure, the existing formal drainage system on the L2545 remains inadequate to fully manage flood risk under extreme conditions.

Measures to address these residual risks—including road elevation, enhanced drainage capacity, and attenuation—are detailed in **Section 7** as part of the proposed development and L2545 upgrade works.

5.4 Groundwater Risk

Groundwater flooding typically occurs after prolonged periods of heavy rainfall, especially in late winter/early spring when the groundwater table is already high. If the groundwater level rises above the ground level, it can accumulate in local low-lying areas, leading to flooding.

Geological and groundwater maps of the site at Ringaskiddy and surrounding were developed from available information on the Geological Survey of Ireland (GSI) website.

The GSI also provides mapping of groundwater flood probability with categories of high, moderate, and low. There are no areas of probable flooding mapped within the proposed development or regional area.

The GSI historical groundwater flooding maps show the observed peak flood extents caused by groundwater in Ireland. There are two localised areas within the category Maximum Historic Groundwater/Surface water flooding located approximately 3km to the west of the proposed development.

The Synthetic Aperture Radar (SAR) seasonal flood maps are produced by the GSI and show observed peak flood extents between Autumn 2015 and Summer 2021. There are no areas of SAR seasonal flood maps within the proposed development or regional area. The nearest SAR seasonal flood area is categorised as "Low Confidence" and is located approximately 4km west of the proposed development, in Carrigaline East. According to the Flood Risk Assessment (FRA) updated in April 2025 there is a low risk of groundwater flooding on the area of the proposed development. Further details are available on the FRA report.

According to the GSI subsoils map, bedrock is mapped as being close to surface (Rck) at the southern end of the site. The northern section of the site is underlain by glacial till derived from Devonian sandstones (TDSs). A portion of the northeastern corner of the site is underlain by marine gravel and sands (often raised) (MGs).

The groundwater vulnerability is predominantly classified as Extreme, with areas where the bedrock is near or at surface. Towards the southeast portion of the proposed development, there are a few areas where the groundwater vulnerability is classified as High and a small area within the cliffs where the groundwater vulnerability is classified as Moderate.

Several ground investigations were completed within the area of the proposed development, including the installation of groundwater monitoring boreholes. A summary is provided below:

- Five groundwater monitoring boreholes (BH1 to BH5) were installed in both the overburden and the bedrock at selected locations across the area of the proposed development as part of the 2000/2001 ground investigations
- Four groundwater monitoring boreholes (MW1 to MW4) were installed as part of the 2011 Hammond Lane ground investigation
- Four groundwater monitoring boreholes were installed as part of the coastal recession mechanisms investigation by Soil Mechanics Ltd in 2012 (BH1 to BH4)
- Four groundwater monitoring boreholes were installed as part of the ground investigation carried out by priority Geotechnical Ltd (PGL) in 2019 (RC03, RC04, RC05, and RC08)

Figure 20 shows the location of groundwater monitoring boreholes located within the proposed development.

Figure 18 Groundwater monitoring installations on site.

Site visits were conducted by Arup engineers between February and April 2025 to collect baseline hydrogeological data in support of the updated EIS for the proposed development. The scope of these site visits is outlined below:

- Manual groundwater readings of all accessible groundwater monitoring boreholes
- Installation of four data loggers recording groundwater levels and one barometric logger
- Two rounds of groundwater sampling and analysis in four groundwater monitoring boreholes

Table 1 and **Table 2** presents a summary of the groundwater level measurements during three site visits including information the ground elevation at the borehole location, groundwater levels and borehole response zone.

Table 3 presents a summary of the groundwater level readings provided by the datalogger in the four boreholes identified as RC03, RC04, RC05 and BH4.

Table 1 Groundwater Levels obtained from manual dips on three site visits in 2025

BHRef.	Ground Level m OD*	Response zone	Groundwater Level m OD			Notes
			26/02/2025	16/04/2025	30/04/2025	
RC03 (2019)	26.16	Bedrock	17.82	13.94	18.19	
RC04 (2019)	6.36	Bedrock	5.21	3.04	4.55	Tidal effect present but only when groundwater level is low
RC05 (2019)	4.49	Bedrock	1.10	0.46	0.77	Tidal
RC08 (2019)	3.12	Bedrock	0.96	-	-	Tidal
BH1 (2012)	7.01	Subsoil	3.26	0.70	-	
BH2 (2012)	8.99	Subsoil	5.14	1.92	2.60	
BH3 (2012)	10.00	Subsoil	7.12	4.93	5.40	
BH4 (2012)	11.60	Subsoil	8.02	6.17	6.14	

*Ground Elevation for the boreholes was taken from the 2012 GI completed by Soil Mechanics Ltd and 2019 GI completed by Priority Geotechnical Ltd

Table 2 Groundwater Levels obtained from manual dips on three site visits in 2025

BHRef.	Groundwater Level mbtoc*			Notes
	Min	Max	Median	
RC03 (2019)	8.44	12.69	8.81	
RC04 (2019)	1.50	3.67	2.16	Tidal effect present but only when groundwater level is low
RC05 (2019)	3.74	4.38	4.07	Tidal
RC08 (2019)	2.54	2.54	2.54	Tidal
BH1 (2012)	3.82	6.38	5.10	
BH2 (2012)	4.00	7.22	6.54	
BH3 (2012)	3.00	5.19	4.72	
BH4 (2012)	3.85	5.73	5.70	

*Monitoring period between 16/04/2025 – 30/04/2025

*mbtoc = meters below top of the casing

Table 3 Groundwater Levels recorded on the data loggers*

BHRef.	Ground Level m OD*	Response zone	Groundwater Level m OD**			Notes
			Maximum	Minimum	Average	
RC03 (2019)	26.16	Bedrock	18.91	13.73	14.51	
RC04 (2019)	6.36	Bedrock	4.72	3.04	4.21	Tidal effect present but only when groundwater level is low
RC05 (2019)	4.49	Bedrock	0.88	0.00	0.45	Tidal
BH4 (2012)	11.60	Subsoil	6.17	6.11	6.13	

*Ground Elevation for the boreholes was taken from the 2012 GI completed by Soil Mechanics Ltd and 2019 GI completed by Priority Geotechnical Ltd

**Monitoring period between 16/04/2025 – 30/04/2025

A hydrograph chart illustrating groundwater level fluctuations is presented in **Figure 21.** This includes data collected from dataloggers and manual dips at monitoring boreholes RC03, RC04, RC05 and BH4. Higher groundwater levels generally occur during wintertime with peak groundwater levels generally between January and February, whilst lower groundwater levels occur during summertime, with the lowest groundwater levels occurring between August and September.

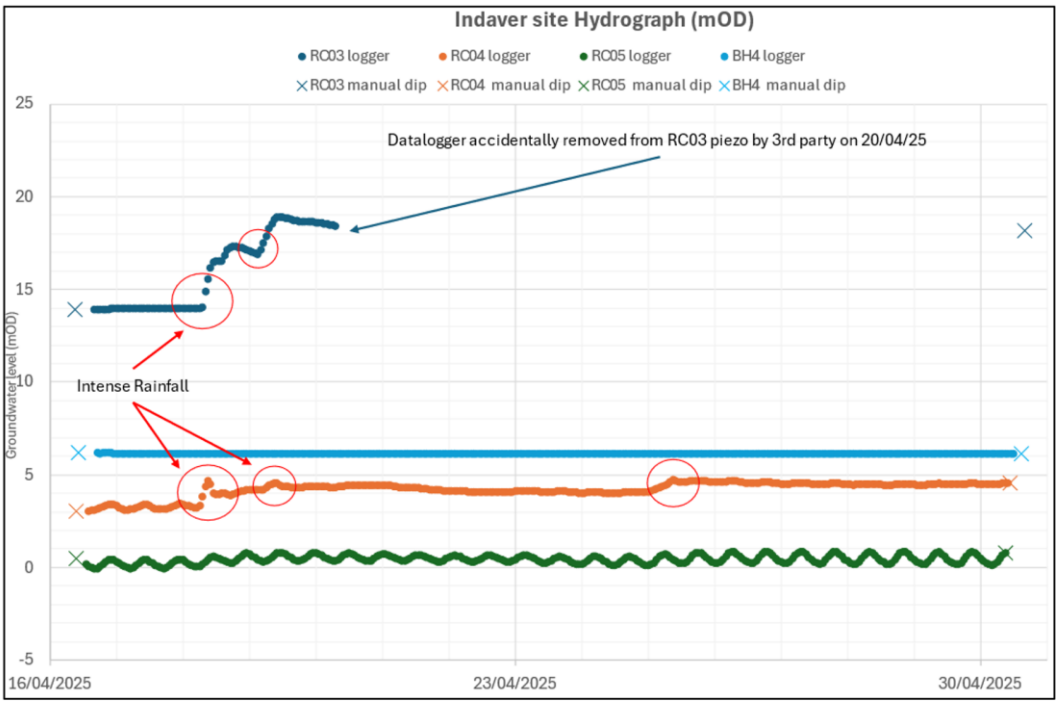

Figure 19 Hydrograph from groundwater level data logger data and manual dips from site visits – RC03, RC04, RC05 and BH4 groundwater monitoring installations.

The results also show that intense rainfall (storm event) resulted in a more significant response on the groundwater levels in the bedrock aquifer recorded by borehole RC03 and RC04 indicating that in these areas the recharge enters the weathered bedrock more rapidly than elsewhere and causes groundwater level to rise. BH4, which monitors the subsoil aquifer, showed a slight and gradual increase in the groundwater levels in response to the intense rainfall. The RC05 borehole, which has tidal influence, didn't show any changes in groundwater level patterns.

Monitoring of groundwater levels over a tidal cycle has been undertaken as part of the site investigation carried out in 2020 and 2021 on a limited number of boreholes. The results at that time showed that fluctuation in groundwater levels around the tidal cycle is very small, circa 0.1m to 0.2m.

At RC04, the groundwater level also showed a tidal influence but only during low groundwater levels. When groundwater levels were higher the tidal influence was not detected.

Groundwater flow tends to move in a north to north-eastwards direction across the site as indicated by the groundwater contour maps for the subsoil and bedrock response zones (**Figure 22**).

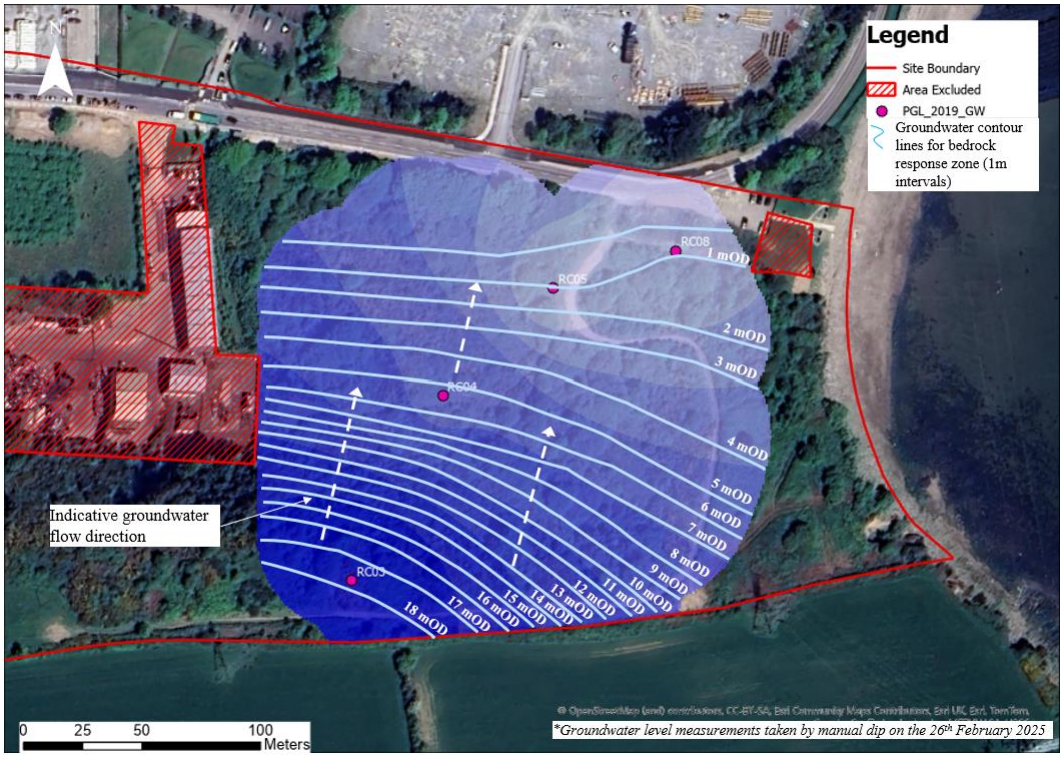

Figure 20 Groundwater Contour Map.

Based on the groundwater level monitoring, there is a small area in the eastern part of the Indaver site, where groundwater may reach the natural ground surface during peak winter groundwater levels. Elsewhere, groundwater levels are anticipated to remain below the natural ground level.

It is proposed to increase the ground levels throughout the site to the proposed site flood defence level of 4.55m OD. This measure will ensure that the risk of flooding to in the northern area of the site, where groundwater is closest to the current ground surface, is very low, as it is not expected to rise up to the new proposed defence level even in extreme events.

6. Establishment of Design Flood Levels

6.1 Predicted 1 in 200-year Design Tidal Level at Indaver Site

Based on a review of all available information, the 1 in 200-year design tidal level at the Indaver site has been estimated as 2.87m OD, as per the ICWWS data.

6.2 Climate Change

The OPW has issued a Guidance on the "Assessment of potential future scenarios for Flood Risk Management" which suggests the use of two scenarios: a mid-range future scenario (MRFS) and a high-end future scenario (HEFS). The MRFS represents a likely future scenario which is within the bounds of the widely accepted projections. The HEFS is a more extreme event and is within the upper bounds of the widely accepted projections. These are detailed within the table below.

Table 4 Allowances for future scenarios

	MRFS	HEFS
Extreme rainfall events	+20%	+30%
Flood flows	+20%	+30%
Mean sea level rise	+500mm	+1000mm
Land movement	-0.5mm/year*	-0.5mm/year*
Urbanisation	No general allowance-review on a case-by-case basis	No general allowance-review on a case-by-case basis
Forestation	-1/6 Tp#	-1/3 Tp# +10% SPR^

*Applicable to the southern part of the country only (Dublin – Galway and south of this).

Reduce the time to peak (Tp) by a third: This allows for potential accelerated runoff that may arise as a result of drainage of afforested land.

^ Add 10% to the Standard Percentage Runoff (SPR) rate: This allows for increased runoff rates that may arise following felling of forestry.

There are a number of conclusions that can be taken from the predictions made on climate change implications:

Increases in sea level may result in extreme tidal events, with tidal levels increasing by more than a metre in the next century (HEFS). This would result in a greater risk of tidal flooding to the Indaver site at Ringaskiddy.

Increase in the frequency of extreme events, particularly hydrological extremes, storms and droughts may cause an increase in rainfall intensity, duration and amount, resulting in increased surface water runoff.

Based on this, it is proposed to account for climate change by considering a 500mm increase in the water levels in the estuary as per the Mid-Range Future Scenario as this represents the most likely future scenario and conforms to current standard practice in tidal flood risk assessments.

6.3 Freeboard

It is generally recognised and accepted in Ireland, that a minimum freeboard of 300mm is adopted with a higher freeboard where this is justified.

Arup has recommended that a 500mm freeboard be used as a conservative approach for this flood risk assessment.

6.4 Proposed Minimum Site Flood Defence Level

From the analysis of the available reports and data, the 200-year design tidal level at the Indaver site was estimated to be 2.87m OD, in line with the current ICWWS data.

In addition to the element of sea level rise, the guidance also notes that this area of the country is subsiding due to Glacial Isostatic Adjustment (GIA). The rate of GIA is given as 0.5mm/year.

Allowing for climate change and the Glacial Isostatic Adjustment (GIA) the minimum design flood defence level of the proposed development can be calculated as:

2.87m OD (200-year tidal level) + 0.50m (climate change) + 0.05 (Glacial Isostatic Adjustment (GIA)) =

3.42m OD

6.5 More Conservative Site Flood Defence Levels

It is noted that the site flood defence level of 3.42m OD calculated in the previous section represents a minimum value of the site flood defence level. Higher defence levels can be used.

There are a number of reasons as to why a more conservative site flood level is merited for the proposed development:

- Given the nature of the proposed development, flooding of the site may lead to negative impacts on the environment – utilising a very conservative site flood defence level will greatly minimise this risk
- A number of recent developments close the Indaver site in Ringaskiddy (Beaufort Research Lab, iMerc Development) have utilised a site flood defence level of 4.55m OD which have set a precedent for a more conservative approach to addressing the risk of tidal flooding in the area
- The previous planning application for the same development in 2008 proposed a more conservative site defence level (4.55m OD) than the currently calculated 3.42m OD level

A more conservative site flood defence level which considers the High-End Future Scenario could therefore be adopted:

2.87m OD (200-year tidal level) + 1.00m (climate change) + 0.05 (Glacial Isostatic Adjustment (GIA)) =

4.42m OD

Given that there is a precedent set by the Beaufort Research Lab and iMerc Development, a site flood defence level of 4.55m OD could also be adopted for the development.

The 4.55m OD would offer a very high standard of protection to the site and would ensure the risk of tidal inundation of the site is very low.

Arup therefore proposes to use a site flood defence level of **4.55m OD**.

6.6 Proposed Flood Defence Level for the L2545 Road

From the analysis of the available reports and data, the 200-year design tidal level at the Indaver site was estimated to be 2.87m OD.

Allowing for climate change, but excluding freeboard, the minimum design flood defence level of the proposed L2545 road upgrade can be calculated as:

2.87m OD (200-year tidal level) + 0.50m (climate change) + 0.05 (Glacial Isostatic Adjustment (GIA)) = 3.42m OD.

7. Management of Flood Risk at the Site

7.1 Increase in Ground Levels Above 1 in 200-year Design Tidal Level

As stated previously, some areas of the site (along the northern boundary and in the western fields) are below the 1 in 200-year design tidal flood level. It is proposed to increase the ground levels throughout the site to the proposed site flood defence level of 4.55m OD. This measure will ensure that the risk of flooding to the site is very low.

7.2 Floor Levels of the Buildings

The minimum site flood defence level was estimated as 3.42m OD. Arup has instead however adopted a more conservative level of 4.55m OD for the site. The finished floor level of the buildings on the site however will be set at even higher levels:

- The administration building and ESB substation will be set at 5.0m OD
- The floor level of the main process building varies from 5.0m to 7.0m OD

- The turbine and aero-condenser buildings will be set at 11m OD

The risk of flooding to all the buildings on the site is therefore very low.

7.3 Roads and Car Parks

The internal roads and car parks within the site will also be raised to the proposed site flood defence level of 4.55m OD. This will ensure that the risk of flooding to the area of the site outside the building is also very low.

It is noted that a small area at the entrance to the site will fall below the 4.55m OD level to facilitate a gradient for vehicles from the access road to the site. As detailed in **Section 7.5**, this area be flush with the access road which will be elevated to above the 200-year design tidal water level plus an allowance for climate change. This small area of the site will therefore still have a high level of protection from flooding.

7.4 Access and Egress Routes to the Site

The Indaver site at Ringaskiddy is accessed by the L2545 road as highlighted in **Figure 23** below. This road runs along the Northern boundary of the site. It is set between circa 2.40m to 2.80m OD to the south and set between circa 2.8m to 4.9m OD to the east. At the proposed entrance to site the existing road level is set at 2.61m OD.

Figure 21 L2545 – site access road (highlighted in red)

The L2545 road is prone to flooding as demonstrated during the February 2014 and October 2004 flood events and described in **Section 3.2.1** and **5.2** of this report. Access and egress routes to the site are therefore at risk of being cut off during extreme rainfall and/or tidal events. Measures to address this risk of flooding are therefore required. These are detailed in the following section.

7.5 Proposed Upgrade of the L2545

It is proposed to upgrade the L2545 to help manage the risk of flooding along the road corridor. The proposed works include raising a 190m section of the road, with the crest set above the design flood level of 3.42m OD. The maximum proposed elevation is 3.495m OD at the centreline, which is approximately 1.0m above the existing road level. This elevation exceeds the 200-year design tidal water level with an allowance for climate change and has been determined through design iteration to comply with vertical road alignment standards. The raised section is intended to improve flood resilience and maintain access to the proposed site during extreme tidal events.

The ground to the south of the road will be raised to meet the proposed waste-to-energy site level of 4.55m OD, offering a high standard of flood protection. Existing ground levels north of the road boundary wall generally provide adequate flood immunity under current climate conditions (up to the 1 in 200-year event). However, in a climate change scenario with a 0.5m sea-level rise, there is potential for floodwater to outflank the raised road crest and flow westward along existing ground levels north of the boundary wall. Additionally, tidal inundation could be conveyed around the eastern extent of the wall near the bend in the L2545 as it turns north toward Haulbowline Island, forming a flow path north of both the wall and the raised road section. This could result in shallow flooding west of the raised crest during future flood events if left unmitigated.

Despite these residual risks, the raised section of road represents a valuable and proactive design measure. It contributes to improved flood immunity under current conditions and helps future-proof the area by forming part of a potential broader flood defence scheme, reducing the need for disruptive roadworks in the future.

It is not proposed to raise the 260m section of existing road from the western boundary of the Indaver site to the start of the raised section, as it will be protected from tidal flooding by the elevated crest to the east. A new dedicated surface water drainage system will also be installed as part of the upgrade works to collect, convey, and store runoff from the road before reconnecting into the existing drainage network for discharge to the foreshore. These works build upon the improvements made under the Ringaskiddy urban realm and active travel scheme, which enhanced the existing drainage infrastructure along the L2545.

7.6 Proposed Surface Water Drainage Along the L2545

Currently the existing surface water drainage network consists of two separate systems which both discharge to the harbour via the 450mm diameter outfall on Gobby Beach:

- 450mm diameter surface water sewer which runs from approximately 200m west of the Hammond & Lane entrance eastwards through the public carpark before discharging to the foreshore on Gobby Beach
- Combination of 225mm and 300mm diameter pipes which run from the bridge on the Haulbowline Road down to the junction of the Haulbowline Road and the L2545 at the public carpark

The majority of the L2545 road runoff does not drain to the 450mm sewer but instead drains to western fields area within Indaver lands on the south side of the road where it infiltrates to the ground.

Arup's design of the proposed drainage network is based on the more critical of the following two scenarios:

- 100-year return period storm event occurring with a Mean High-Water Spring (MHWS) tidal event (1.72m OD)
- 30-year return period storm event occurring with a 200 year tidal event (2.87m OD)

The most severe scenario is the 30-year rainfall event combined with the 200 year tidal event.

As part of the proposed Indaver development all surface water runoff from the L2545 road which currently discharges to the western fields south of the road will be collected in a series of road gullies and conveyed to the outfall for discharge to the foreshore via a new surface water attenuation structure.

Due to the high-water level of the 200-year design tide, 2.87m O.D, the outfall to Gobby Beach will be submerged for approximately 7 hours during the tidal event (the invert level of the outfall is set at -0.28m OD). It is proposed to construct a new surface water attenuation structure under the upgraded road to attenuate all runoff generated from the drainage catchment while the submerged outfall is restricted due to the 200-year tide level.

During this scenario of the 30-year rainfall event coinciding with the 200 year tidal event 660m³ of attenuation volume will be required to store the runoff from the catchment while the outfall is submerged.

It is proposed to provide the required storage in 2 no. 1500mm∅ pipes approximately 190m in length which will be located under the raised section of the L2545.

The proposed L2545 road drainage upgrade will consist of approximately 260m of surface water channel on the section not being raised, which will discharge at regular intervals to the existing 450mm diameter surface water carrier pipe, and a kerb and gully system on the proposed raised section of the road. The gullies will discharge into the new surface water drainage system.

It is not proposed to construct a new outfall to the foreshore as the new drainage system will connect back into the existing 450mm diameter sewer in the vicinity of the public carpark prior to the discharge to the foreshore.

The proposed drainage improvements build upon and integrate with the enhancements made under the Ringaskiddy urban realm and active travel scheme, with upgraded sections of the existing drainage infrastructure along the L2545.

All of the above works will be within Indaver's ownership, apart from a small area in Hammond Lane's ownership and a regraded entrance area on lands owned by Port of Cork. Both companies have been consulted in relation to these upgrade works.

7.7 Coastal Erosion Study

A wave modelling and erosion study of the area of the Indaver site was undertaken by Arup in 2015 and is detailed in the Coastal Erosion Report submitted as part of the 2016 planning application. An updated coastal assessment which builds on previous submissions by incorporating to the 2016 Coastal Erosion Study was undertaken in 2025 as part of the 2025 EIS (Refer to **Appendix 13.3** ***Coastal Erosion Study EIS 2025***).

Based on the Coastal Erosion Study (2025) Arup has recommended that the Indaver coastal boundary is monitored on an annual basis and the placement of approximately 1150m^3 of sacrificial material (shingle of appropriate size and rounded shape with high density and resistance to abrasion) above the foreshore on Gobby beach along the eastern boundary of the Indaver site.

This will be a 'soft' solution which will potentially reduce erosion rates by limiting the exposure of the toe of the glacial till face to wave action. The main aim of placing the material is to act as a proactive measure for the coastal area adjacent to the Indaver site only.

The solution will have no negative impacts on the adjoining areas. However, there are benefits associated with the works as well as the provision of an environmentally friendly solution. The closest area of the Cork Harbour Special Protection Area (SPA) is located to the southwest of the site. The net coastal sediment transport goes from south to north according to wind conditions and swell and therefore, the beach nourishment material is likely to move towards the north in the medium and long term. Therefore, the sacrificial material will not impact on this part of the SPA. Other sections of the SPA which are to the north of the site are more than two kilometres from the site and these are too remote from the site to receive any significant quantities of beach nourishment material.

The reader is referred to the report for a detailed description of this work.

8. Application of 'Flood Risk Management Guidelines'

8.1 Vulnerability Classification

It is considered that the proposed resource recovery centre at Ringaskiddy should be classified as a "Highly Vulnerable Development" as per the vulnerability classification below given that it will be a waste treatment facility which treats both non-hazardous and hazardous waste and will require an Industrial Emissions Licence from the Environmental Protection Agency.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).
*Uses not listed here should be considered on their own merits	

Figure 22 Vulnerability classification

8.2 Flood Zones

As indicated in **Section 3** of this report, the site of the proposed development is not within the 1 in 200 year or 1 in 1000-year design tidal floodplain. Consequently, in accordance with the November 2009 OPW Guidelines for Planning Authorities, the site is within Flood Zone C.

As all types of development are acceptable within Flood Zone C, a Justification Test is not required for the proposed development.

8.3 Sequential Approach

The figure below illustrates the sequential approach to be adopted under the 'Planning System and Flood Risk Management' guidelines.

As the proposed development lies within Flood Zone C, a Justification Test is not required, and it is necessary only to identify mitigation measures for any residual risks.

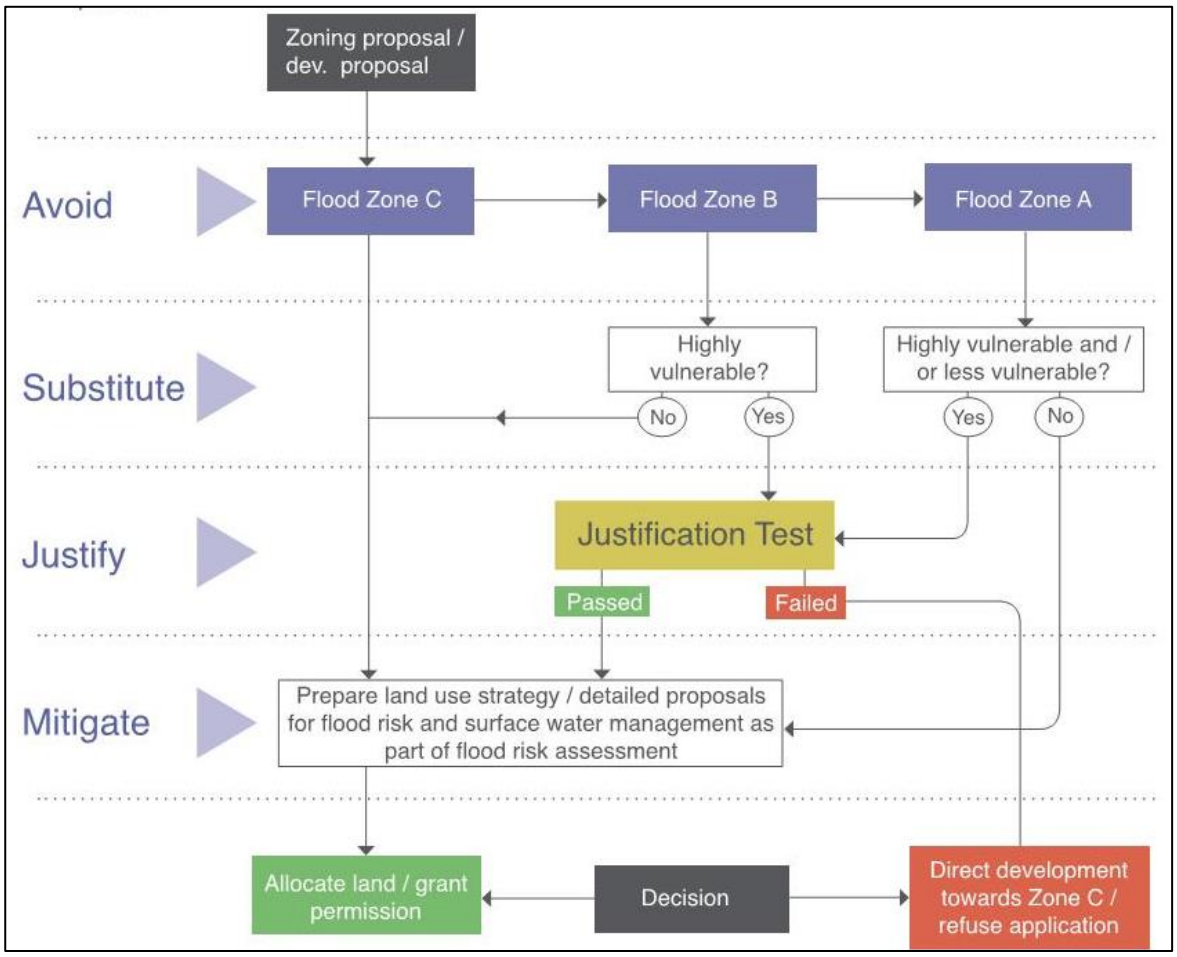

Figure 23 Sequential approach

9. Conclusions

It was shown that the site is located in Flood Zone C as it outside the 1 in 1000-year design tidal floodplain.

The minimum design flood defence level of the proposed development was calculated as 3.42mOM. Arup however have proposed a far more conservative flood defence level of 4.55m OD for the site.

It is proposed to raise the footprint of the entire site to the proposed site flood defence level of 4.55m OD. This includes all the buildings, internal roads, car parking area and all associated site works. This measure will ensure that the risk of flooding to the site is remote.

It is proposed to upgrade the L2445 to address the risk of flooding of the road. The upgrade works will include raising a 190m section of the road to a maximum height of 3.495m OD between the car park adjacent to Gobby Beach and the Eastern end of the Hammond Lane Metal Company site. This is approximately 0.9m above the existing road level. This will elevate the road to above the 200-year design tidal water level plus an allowance for climate change. This will offer a high level of protection to the road from tidal flooding and can help ensure that access and egress routes are maintained during flood events.

A new dedicated surface water drainage system will be installed as part of the L2545 upgrade works to collect, convey, and attenuate runoff from the road before reconnecting into the existing drainage network for discharge to the foreshore. These improvements build upon the enhancements delivered through the Ringaskiddy urban realm and active travel scheme and are intended to improve the road's resilience to pluvial flooding and tide-locking during extreme weather events.

These measures are sufficient to ensure that the risk of flooding of the site and its access road is very low.

It is considered that the proposed resource recovery centre at Ringaskiddy should be classified as a "Highly Vulnerable Development" as per the vulnerability classification. As the site is classified as Flood Zone C, a Justification Test is not required for the proposed development, and it is necessary only to identify mitigation measures for any residual risks (i.e. an appropriate development level, that being 4.55 m OD).